

What is claimed is:

1. A device for filtering emboli from blood flowing through a lumen defined by the walls of a vessel comprising:

5 a guidewire;

a filter element carried on a distal portion of the guidewire, the filter element having a distal end, the guidewire extending to at least the distal end of the filter element, the filter element being expandable from a collapsed delivery configuration when the filter is constrained to an expanded deployed configuration when the filter element is unrestrained, the filter element having a shape in the expanded configuration which forms a cavity having a proximally facing opening defining a proximally facing lip; and

10 a plurality of retraction members, each retraction member having a distal portion which engages the proximally facing lip of the filter element and a proximal end connected to the guidewire and an intermediate portion between the proximal end and distal portion, the retraction members being configured such that when the intermediate portions of the retraction members are moved towards the guidewire the proximally facing lip of the filter element is drawn radially inwardly in the direction of the guidewire.

15 2. The device of claim 1 wherein the filter element is self-expandable.

20 3. The device of claim 1 further comprising means for expanding the filter element from the collapsed configuration to the expanded configuration.

25 4. The device of claim 3 wherein the means for expanding comprises the filter element being comprised of nitinol.

5. The device of claim 1 wherein the filter element is attached to the guidewire at a distal region of the guidewire.

6. The device of claim 1 wherein the distal end of the filter element is connected to a distal band which encircles the guidewire.

7. The device of claim 6 wherein the distal band is connected in a fixed position on the guidewire.

8. The device of claim 6 wherein the proximal end of the filter element is connected to a proximal band which encircles the guidewire.

9. The device of claim 8 wherein one of the proximal and distal bands is connected at a fixed position on the guidewire.

10. The device of claim 8 wherein the proximal band is slidably disposed about the guidewire.

11. The device of claim 8 wherein when the filter element is in the collapsed configuration the distal and proximal bands are spaced apart a first distance and when the filter element is in the expanded configuration the proximal and distal bands are spaced apart a second distance, the first distance being greater than the second distance.

12. The device of claim 1 wherein when the filter element is in the expanded configuration a proximal portion of the filter element is of sufficient size and shape to engage the wall of the vessel.

13. The device of claim 12 wherein the filter element has a shape in the expanded configuration which decreases in size from the proximal portion to the distal end of the filter element.

5 14. The device of claim 1 wherein the filter element comprises a metal mesh.

15. The device of claim 14 wherein the filter element comprises nitinol.

10 16. The device of claim 1 wherein the guidewire includes a flexible portion extending distally of the distal end of the filter element.

17. The device of claim 1 wherein the guidewire extends through the cavity to at least the distal end of the filter element.

15 18. The device of claim 1 wherein the guidewire comprises a solid material.

19. The device of claim 1 wherein the guidewire comprises metal.

20 20. The device of claim 1 wherein the guidewire comprises a tapered portion.

21. The device of claim 1 wherein the retraction members comprise a non-rigid material.

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22. A device for filtering emboli from blood flowing through a lumen defined by the walls of a vessel comprising:

30 a filter element having a distal end, the filter element being expandable from a collapsed delivery configuration when the filter is constrained to an expanded deployed configuration when the filter element is unrestrained, the filter element having a shape in the expanded

configuration which forms a cavity having a proximally facing opening defining a proximally facing lip; and

means for carrying the filter element, the carrying means extending to at least the distal end of the filter element; and

5 a plurality of retraction members, each retraction member having a distal portion which engages the proximally facing lip of the filter element and a proximal end connected to the carrying means and an intermediate portion between the proximal end and distal portion, the retraction members being configured such that when the intermediate portions of the retraction members are moved towards the carrying means the proximally facing lip of the filter element is drawn radially inwardly in the direction of the carrying means.

23. A device for filtering emboli comprising:

15 a guidewire;

a filter element carried on a distal portion of the guidewire, the filter element having a distal end, the guidewire extending to at least the distal end of the filter element, the filter element being expandable from a collapsed delivery configuration to an expanded deployed configuration, the filter element having a shape in the expanded configuration which forms a cavity having a proximally facing opening at a proximal end of the filter element, the filter element being collapsible from the expanded deployed configuration to a retrieval configuration, the proximally facing opening being substantially closed in the retrieval configuration; and

25 a plurality of retraction members, each retraction member having a distal end connected to engage the proximal end of the filter element in the expanded configuration and a proximal end connected to the guidewire and an intermediate portion between the proximal and distal ends of the retraction member, the retraction members being configured such that when the intermediate portions of the retraction members are moved towards the

guidewire the filter element is collapsed from its expanded deployed configuration to its retrieval configuration.

24. The device of claim 23 wherein the filter element is self-expandable.

25. The device of claim 23 further comprising means for expanding the filter element from the collapsed configuration to the expanded configuration.

26. The device of claim 25 wherein the means for expanding comprises the filter element being comprised of nitinol.

27. The device of claim 23 wherein the filter element is attached to the guidewire at a distal region of the guidewire.

28. The device of claim 23 wherein the distal end of the filter element is connected to a distal band which encircles the guidewire.

29. The device of claim 28 wherein the distal band is connected at a fixed position on the guidewire.

30. The device of claim 28 wherein the proximal end of the filter element is connected to a proximal band which encircles the guidewire.

31. The device of claim 30 wherein one of the proximal and distal bands is connected at a fixed position on the guidewire.

32. The device of claim 30 wherein the proximal band is slidably disposed about the guidewire.

33. The device of claim 30 wherein when the filter element is in the collapsed configuration the distal and proximal bands are spaced apart a first distance and when the filter element is in the expanded configuration the proximal and distal bands are spaced apart a second distance, the first distance being greater than the second distance.

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34. The device of claim 23 wherein when the filter element is in the expanded configuration a proximal portion of the filter element is of sufficient size and shape to engage the wall of the vessel.

35. The device of claim 34 wherein the filter element has a shape in the expanded configuration which decreases in size from the proximal portion to the distal end of the filter element.

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36. The device of claim 23 wherein the filter element comprises a metal mesh.

37. The device of claim 36 wherein the filter element comprises nitinol.

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38. The device of claim 23 wherein the guidewire includes a flexible portion extending distally of the distal end of the filter element.

39. The device of claim 23 wherein the guidewire extends through the cavity to at least the distal end of the filter element.

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40. The device of claim 23 wherein the guidewire comprises a solid material.

41. The device of claim 23 wherein the guidewire comprises metal.

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42. The device of claim 23 wherein the guidewire comprises a tapered portion.

43. The device of claim 23 wherein the retraction members comprise a non-rigid material.

44. A device for filtering emboli comprising:

a filter element having a distal end, the filter element being expandable from a collapsed delivery configuration to an expanded deployed configuration, the filter element having a shape in the expanded configuration which forms a cavity having a proximally facing opening at a proximal end of the filter element, the filter element being collapsible from the expanded deployed configuration to a retrieval configuration, the proximally facing opening being substantially closed in the retrieval configuration;

means for carrying the filter element, the carrying means extending to at least the distal end of the filter element; and

a plurality of retraction members, each retraction member having a distal end connected to engage the proximal end of the filter element in the expanded configuration and a proximal end connected to the carrying means and an intermediate portion between the proximal and distal ends of the retraction member, the retraction members being configured such that when the intermediate portions of the retraction members are moved towards the carrying means the filter element is collapsed from its expanded deployed configuration to its retrieval configuration.

45. A device for filtering emboli comprising:

a guidewire;

a filter element carried on a distal portion of the guidewire, the filter element having a distal end, the guidewire extending to at least the distal

end of the filter element, the filter element being expandable from a collapsed delivery configuration to an expanded deployed configuration, the filter element having a shape in the expanded configuration which forms a cavity having a proximally facing opening at a proximal end of the filter element, the proximally facing opening having peripheral edge, the filter element being collapsible from the expanded deployed configuration to a retrieval configuration, the proximally facing opening being substantially closed in the retrieval configuration; and

at least one tether having a first end engaging the peripheral edge of the filter element and a second end attached to the guidewire, the at least one tether being configured such that when the tether is drawn inwardly toward the guidewire it will act as a drawstring to collapse the peripheral edge of the filter element toward the guidewire.

46. The device of claim 45 wherein the at least one tether comprises a wire having first and second ends, the first end of the wire engaging the peripheral edge of the filter element and the second end of the wire being attached to the guidewire.

47. The device of claim 45 wherein the at least one tether comprises a wire attached at each end to the guidewire and extending about the peripheral edge of the filter element.

48. A device for filtering emboli comprising:

a filter element having a distal end, the filter element being expandable from a collapsed delivery configuration to an expanded deployed configuration, the filter element having a shape in the expanded configuration which forms a cavity having a proximally facing opening at a proximal end of the filter element, the proximally facing opening having a peripheral edge, the filter element being collapsible from the expanded



deployed configuration to a retrieval configuration, the proximally facing opening being substantially closed in the retrieval configuration;

means for carrying the filter element, the carrying means extending to at least the distal end of the filter element; and

at least one tether having a first end engaging the peripheral edge of the filter element and a second end attached to the carrying means, the at least one tether being configured such that when the tether is drawn inwardly toward the carrying means it will act as a drawstring to collapse the peripheral edge of the filter element toward the carrying means.

49. A method for filtering emboli from blood flowing through a lumen defined by the walls of a vessel at a desired location in the vessel comprising:

providing a guidewire;

providing a filter element carried on a distal portion of the guidewire, the filter element having a distal end, the guidewire extending to at least the distal end of the filter element, the filter element being expandable from a collapsed delivery configuration when the filter element is constrained to an expanded deployed configuration when the filter element is unrestrained, the filter element having a shape in the expanded configuration which forms a cavity having proximally facing opening defined by a proximally facing lip;

providing a plurality of retraction members, each retraction member having a distal end which engages the proximally facing lip of the filter element and a proximal end connected to the guidewire and an intermediate portion between the proximal and distal ends, the retraction members being configured such that when the intermediate portions of the retraction members are moved towards the guidewire the proximally facing lip of the filter element is drawn radially inwardly in the direction of the guidewire;

advancing the guidewire and filter element in its collapsed delivery configuration through the vessel until the filter element is located at the desired location;

expanding the filter element to its expanded deployed configuration;

filtering emboli from blood flowing through the vessel with the filter;

moving the intermediate portions of the retraction members towards the guidewire to draw the proximally facing lip of the filter element radially inwardly in the direction of the guidewire until the proximally facing opening is substantially closed; and

withdrawing the guidewire and filter element from the vessel.

50. The method of claim 49 wherein the step of moving the distal ends of the retraction members comprises drawing the intermediate portions of the retraction members radially inwardly beginning at the proximal end of the retraction members and advancing distally towards the distal end of the retraction members.

51. A method for filtering emboli from blood flowing through a lumen defined by the walls of a vessel at a desired location in the vessel comprising:

providing a filter device including a filter element and means for carrying the filter element, the filter element having a distal end, the carrying means extending to at least the distal end of the filter element, the filter element being expandable from a collapsed delivery configuration when the filter element is constrained to an expanded deployed configuration when the filter element is unrestrained, the filter element having a shape in the expanded configuration which forms a cavity having proximally facing opening defined by a proximally facing lip;

providing a plurality of retraction members, each retraction member having a distal end which engages the proximally facing lip of the filter

element and a proximal end connected to the carrying means and an intermediate portion between the proximal and distal ends, the retraction members being configured such that when the intermediate portions of the retraction members are moved towards the carrying means the proximally facing lip of the filter element is drawn radially inwardly in the direction of the carrying means ;

advancing the carrying means and filter element in its collapsed delivery configuration through the vessel until the filter element is located at the desired location;

expanding the filter element to its expanded deployed configuration; filtering emboli from blood flowing through the vessel with the filter;

moving the intermediate portions of the retraction members towards the carrying means to draw the proximally facing lip of the filter element radially inwardly in the direction of the carrying means until the proximally facing opening is substantially closed; and

withdrawing the carrying means and filter element from the vessel.

52. A method for filtering emboli from blood flowing through the lumen of a vessel at a desired location comprising:

providing a guidewire;

providing a filter element carried on a distal portion of the guidewire, the filter element having a distal end, the guidewire extending to at least the distal end of the filter element, the filter element being expandable from a collapsed delivery configuration to an expanded deployed configuration, the filter element having a shape in the expanded configuration which forms a cavity having a proximally facing opening at a proximal end of the filter element, the filter element being collapsible from the expanded deployed configuration to a retrieval configuration, the proximally facing opening being substantially closed in the retrieval configuration;

providing a plurality of retraction members, each retraction member having a distal end which engages the proximal end of the filter element in the expanded configuration and a proximal end connected to the guidewire and an intermediate portion between the proximal and distal ends, the retraction members being configured such that when the intermediate portions of the retraction members are moved towards the guidewire the filter element is collapsed from its expanded deployed configuration to its retrieval configuration;

advancing the guidewire and filter element in its collapsed delivery configuration through the vessel until the filter element is located at the desired location;

expanding the filter element to its expanded deployed configuration; filtering emboli from blood flowing through the vessel with the filter;

moving the intermediate portions of the retraction members towards the guidewire to collapse the filter element from its expanded deployed configuration to its retrieval configuration; and

withdrawing the guidewire and filter element from the vessel.

53. A system for filtering emboli from blood flowing through a lumen defined by the walls of a vessel comprising:

a guidewire;

a filter element carried on a distal portion of the guidewire, the filter element having a distal end, the guidewire extending to at least the distal end of the filter element, the filter element being expandable from a collapsed delivery configuration when the filter is constrained to an expanded deployed configuration when the filter element is unrestrained, the filter element having a shape in the expanded configuration which forms a cavity having a proximally facing opening defined by a proximally facing lip;

5 a plurality of retraction members, each retraction member having a distal end which engages the proximally facing lip of the filter element and a proximal end connected to the guidewire and an intermediate portion between the proximal and distal ends of the retraction member, the retraction members being configured such that when the intermediate portions of the retraction members are moved towards the guidewire the proximally facing lip of the filter element is drawn radially inwardly in the direction of the guidewire; and

10 a retrieval catheter having a lumen sized to accommodate the guidewire and the retraction members, the retrieval catheter being slidable over the guidewire, the lumen of the retrieval catheter being sized such that when the retrieval catheter is moved distally along the guidewire from the proximal ends of the retraction members towards the distal ends of the retraction members when the filter element is in the expanded deployed configuration the intermediate portions are drawn into the lumen of the retrieval catheter and the distal ends of the retraction members are moved towards the guidewire.

54. A system for filtering emboli from blood flowing through a lumen defined by the walls of a vessel comprising:

20 a filter element having a distal end, the filter element being expandable from a collapsed delivery configuration when the filter is constrained to an expanded deployed configuration when the filter element is unrestrained, the filter element having a shape in the expanded configuration which forms a cavity having a proximally facing opening defined by a proximally facing lip;

25 means for carrying the filter element, the carrying means extending to at least the distal end of the filter element; and

30 a plurality of retraction members, each retraction member having a distal end which engages the proximally facing lip of the filter element and

a proximal end connected to the carrying means and an intermediate portion between the proximal and distal ends of the retraction member, the retraction members being configured such that when the intermediate portions of the retraction members are moved towards the carrying means the proximally facing lip of the filter element is drawn radially inwardly in the direction of the carrying means ; and

a retrieval catheter having a lumen sized to accommodate the carrying means and the retraction members, the retrieval catheter being slidable over the carrying means, the lumen of the retrieval catheter being sized such that when the retrieval catheter is moved distally along the carrying means from the proximal ends of the retraction members towards the distal ends of the retraction members when the filter element is in the expanded deployed configuration the intermediate portions are drawn into the lumen of the retrieval catheter and the distal ends of the retraction members are moved towards the carrying means.

55. The system of claim 54 wherein the carrying means comprises a guidewire.

56. A system for filtering emboli comprising:  
a guidewire;

a filter element carried on a distal portion of the guidewire, the filter element having a distal end, the guidewire extending to at least the distal end of the filter element, the filter element being expandable from a collapsed delivery configuration to an expanded deployed configuration, the filter element having a shape in the expanded configuration which forms a cavity having a proximally facing opening at a proximal end of the filter element, the filter element being collapsible from the expanded deployed configuration to a retrieval configuration, the proximally facing opening being substantially closed in the retrieval configuration;

a plurality of retraction members, each retraction member having a first end which engages the proximal end of the filter element in the expanded configuration and a second end connected to the guidewire and an intermediate portion between the first and second ends, the retraction members being configured such that when the intermediate portions of the retraction members are moved towards the guidewire the filter element is collapsed from its expanded deployed configuration to its retrieval configuration; and

a retrieval catheter having a lumen sized to accommodate the guidewire and the retraction members, the retrieval catheter being slidable over the guidewire, the lumen of the retrieval catheter being sized such that when the retrieval catheter is moved distally over the guidewire from the second ends towards the first ends of the retraction members when the filter element is in the expanded deployed configuration the intermediate portions are drawn into the lumen of the retrieval catheter and the distal ends of the retraction members are moved towards the guidewire.

57. A system for filtering emboli comprising:

a filter element having a distal end, the filter element being expandable from a collapsed delivery configuration to an expanded deployed configuration, the filter element having a shape in the expanded configuration which forms a cavity having a proximally facing opening at a proximal end of the filter element, the filter element being collapsible from the expanded deployed configuration to a retrieval configuration, the proximally facing opening being substantially closed in the retrieval configuration;

means for carrying the filter element, the carrying means extending to at least the distal end of the filter element;

a plurality of retraction members, each retraction member having a first end which engages the proximal end of the filter element in the

expanded configuration and a second end connected to the carrying means and an intermediate portion between the first and second ends, the retraction members being configured such that when the intermediate portions of the retraction members are moved towards the carrying means the filter element is collapsed from its expanded deployed configuration to its retrieval configuration; and

a retrieval catheter having a lumen sized to accommodate the carrying means and the retraction members, the retrieval catheter being slidable over the carrying means, the lumen of the retrieval catheter being sized such that when the retrieval catheter is moved distally over the carrying means from the second ends towards the first ends of the retraction members when the filter element is in the expanded deployed configuration the intermediate portions are drawn into the lumen of the retrieval catheter and the distal ends of the retraction members are moved towards the carrying means.

58. The system of claim 57 wherein the carrying means is a guidewire.

59. A method for filtering emboli from blood flowing through a lumen defined by the walls of a vessel at a desired location in the vessel comprising:

providing a guidewire;

providing a filter element carried on a distal portion of the guidewire, the filter element having a distal end, the guidewire extending to at least the distal end of the filter element, the filter element being expandable from a collapsed delivery configuration when the filter is constrained to an expanded deployed configuration when the filter element is unrestrained, the filter element having a shape in the expanded configuration which forms a cavity having a proximally facing opening defined by a proximally facing lip;



a plurality of retraction members, each retraction member having a distal end which engages the proximally facing lip and a proximal end connected to the guidewire and an intermediate portion between the proximal and distal ends;

5 providing a retrieval catheter having a lumen sized to accommodate the guidewire and the retraction members, the retrieval catheter having a distal end;

10 advancing the guidewire and filter element in its collapsed delivery configuration through the vessel until the filter element is located at the desired location;

expanding the filter element to its expanded deployed configuration; filtering emboli from blood flowing through the vessel with the filter;

15 advancing the retrieval catheter through the vessel distally along the guidewire while the filter element is in the expanded deployed configuration until the distal end of the retrieval catheter is moved from the proximal ends of the retraction members towards the distal ends of the retraction members so that the intermediate portions are drawn into the lumen of the retrieval catheter and the distal ends of the retraction members are moved towards the guidewire to draw the proximally facing lip of the filter element radially inwardly in the direction of the guidewire until the proximally facing opening is substantially closed; and

20 withdrawing the retrieval catheter, guidewire and filter element from the vessel.

25 60. A method for filtering emboli from blood flowing through a lumen defined by the walls of a vessel at a desired location in the vessel comprising:

30 providing a filter element and means for carrying the filter element, the filter element having a distal end, the carrying means extending to at least the distal end of the filter element, the filter element being expandable

from a collapsed delivery configuration when the filter is constrained to an expanded deployed configuration when the filter element is unrestrained, the filter element having a shape in the expanded configuration which forms a cavity having a proximally facing opening defined by a proximally facing lip;

a plurality of retraction members, each retraction member having a distal end which engages the proximally facing lip and a proximal end connected to the carrying means and an intermediate portion between the proximal and distal ends;

providing a retrieval catheter having a lumen sized to accommodate the carrying means and the retraction members, the retrieval catheter having a distal end;

advancing the carrying means and filter element in its collapsed delivery configuration through the vessel until the filter element is located at the desired location;

expanding the filter element to its expanded deployed configuration; filtering emboli from blood flowing through the vessel with the filter;

advancing the retrieval catheter through the vessel distally along the carrying means while the filter element is in the expanded deployed configuration until the distal end of the retrieval catheter is moved from the proximal ends of the retraction members towards the distal ends of the retraction members so that the intermediate portions are drawn into the lumen of the retrieval catheter and the distal ends of the retraction members are moved towards the carrying means to draw the proximally facing lip of the filter element radially inwardly in the direction of the carrying means until the proximally facing opening is substantially closed; and

withdrawing the retrieval catheter, carrying means and filter element from the vessel.

61. The method of claim 60 wherein in the step of providing a filter element the carrying means is a guidewire.

62. A method for filtering emboli from blood flowing through a lumen defined by the walls of a vessel at a desired location in the vessel comprising:

providing a guidewire;

providing a filter element carried on a distal portion of the guidewire, the filter element having a distal end, the guidewire extending to at least the distal end of the filter element, the filter element being expandable from a collapsed delivery configuration when the filter is constrained to an expanded deployed configuration when the filter element is unrestrained, the filter element having a shape in the expanded configuration which forms a cavity having a proximally facing opening defined by a proximally facing lip;

a plurality of retraction members, each retraction member having a distal end which engages the proximally facing lip and a proximal end connected to the guidewire and an intermediate portion between the proximal and distal ends;

providing a retrieval catheter having a lumen sized to accommodate the guidewire and the retraction members, the retrieval catheter having a distal end;

advancing the guidewire and filter element in its collapsed delivery configuration through the vessel until the filter element is located at the desired location;

expanding the filter element to its expanded deployed configuration; filtering emboli from blood flowing through the vessel with the filter;

advancing the retrieval catheter through the vessel distally along the guidewire while the filter element is in the expanded deployed configuration until the distal end of the retrieval catheter is moved from the

proximal ends of the retraction members towards the distal ends of the retraction members so that the intermediate portions are drawn into the lumen of the retrieval catheter and the distal ends of the retraction members are moved towards the guidewire to draw the proximally facing lip of the filter element radially inwardly in the direction of the guidewire until the

proximally facing opening is substantially closed; and  
withdrawing the retrieval catheter, guidewire and filter element from the vessel.

63. A method for filtering emboli from blood flowing through the lumen of a vessel at a desired location comprising:

providing a filter element and means for carrying the filter element, the filter element having a distal end, the carrying means extending to at least the distal end of the filter element, the filter element being expandable from a collapsed delivery configuration to an expanded configuration which forms a cavity having a proximally facing opening at a proximal end of the filter element, the filter element being collapsible from the expanded deployed configuration to a retrieval configuration, the proximally facing opening being substantially closed in the retrieval configuration;

providing a plurality of retraction members, each retraction member having a distal end which engages the proximal end of the filter element in the expanded configuration and a proximal end connected to the carrying means and an intermediate portion between the proximal and distal ends, the retraction members being configured such that when the distal ends of the retraction members are moved towards the carrying means the filter element is collapsed from its expanded deployed configuration to its retrieval configuration;

providing a retrieval catheter having a lumen sized to accommodate the carrying means and the retraction members, the retrieval catheter having a distal end;

advancing the carrying means and filter element in its collapsed delivery configuration through the vessel until the filter element is located at the desired location;

expanding the filter element to its expanded deployed configuration;

filtering emboli from blood flowing through the vessel with the filter;

advancing the retrieval catheter distally through the vessel along the carrying means while the filter element is in the expanded deployed configuration until the retraction members are drawn into the lumen of the retrieval catheter causing the filter element to collapse from its expanded deployed configuration to its retrieval configuration; and

withdrawing the retrieval catheter, carrying means and filter element from the vessel.

64. The method of claim 63 wherein in the step of providing a filter element the carrying means is a guidewire.

65. A system for filtering emboli from blood flowing through a lumen defined by the walls of a vessel comprising:

a delivery catheter defining a lumen extending therethrough, the delivery catheter sized to be accommodated within the lumen of the vessel;

a guidewire sized to be accommodated within the lumen of the delivery catheter;

a filter element carried on a distal portion of the guidewire, the filter element having a distal end, the guidewire extending to at least the distal end of the filter element, the filter element being expandable from a collapsed delivery configuration when the filter is contained within the lumen of the delivery catheter to an expanded deployed configuration when the filter element is unrestrained, the filter element having a shape in the

expanded configuration which forms a cavity having a proximally facing opening defined by a proximally facing lip;

a plurality of retraction members, each retraction member having a distal end engaging the proximally facing lip and a proximal end connected to the guidewire and an intermediate portion between the proximal and distal ends of the retraction members, the retraction members being configured such that when the intermediate portion of the retraction members are moved towards the guidewire the proximally facing lip of the filter element is drawn radially inwardly in the direction of the guidewire; and

a retrieval catheter having a lumen sized to accommodate the guidewire and the retraction members, the retrieval catheter being slidable over the guidewire, the lumen of the retrieval catheter being sized such that when the retrieval catheter is moved distally along the guidewire from the proximal ends of the retraction members towards the distal ends of the retraction members when the filter element is in the expanded deployed configuration the intermediate portions are drawn into the lumen of the retrieval catheter and the distal ends of the retraction members are moved towards the guidewire.

66. A system for filtering emboli from blood flowing through a lumen defined by the walls of a vessel comprising:

a delivery catheter defining a lumen extending therethrough, the delivery catheter sized to be accommodated within the lumen of the vessel;

a filter element having a distal end, the filter element being expandable from a collapsed delivery configuration when the filter is contained within the lumen of the delivery catheter to an expanded deployed configuration when the filter element is unrestrained, the filter element having a shape in the expanded configuration which forms a cavity having a proximally facing opening defined by a proximally facing lip;

means for carrying the filter element, the carrying means extending to at least the distal end of the filter element; and

a plurality of retraction members, each retraction member having a distal end engaging the proximally facing lip and a proximal end connected to the carrying means and an intermediate portion between the proximal and distal ends of the retraction members, the retraction members being configured such that when the intermediate portion of the retraction members are moved towards the carrying means the proximally facing lip of the filter element is drawn radially inwardly in the direction of the carrying means; and

a retrieval catheter having a lumen sized to accommodate the carrying means and the retraction members, the retrieval catheter being slidable over the carrying means, the lumen of the retrieval catheter being sized such that when the retrieval catheter is moved distally along the carrying means from the proximal ends of the retraction members towards the distal ends of the retraction members when the filter element is in the expanded deployed configuration the intermediate portions are drawn into the lumen of the retrieval catheter and the distal ends of the retraction members are moved towards the carrying means.

67. The system of claim 66 wherein the carrying means comprises a guidewire.

68. A system for filtering emboli comprising:

a first catheter comprising a delivery catheter defining a lumen extending therethrough, the delivery catheter sized to be accommodated within the lumen of the vessel

a guidewire sized to be accommodated within the lumen of the delivery catheter;

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a filter element carried on a distal portion of the guidewire, the filter  
element having a distal end, the filter element being expandable from a  
collapsed delivery configuration when the filter is contained within the  
lumen of the delivery catheter to an expanded deployed configuration, the  
5 filter element having a shape in the expanded configuration which forms a  
cavity having a proximally facing opening at a proximal end of the filter  
element, the filter element being collapsible from the expanded deployed  
configuration to a retrieval configuration, the proximally facing opening  
being substantially closed in the retrieval configuration;

10 a plurality of retraction members, each retraction member having a  
distal end which engages the proximal end of the filter element in the  
expanded configuration and a proximal end connected to the guidewire and  
an intermediate portion between the proximal and distal ends of the  
retraction member, the retraction members being configured such that when  
15 the intermediate portions of the retraction members are moved towards the  
guidewire the filter element is collapsed from its expanded deployed  
configuration to its retrieval configuration; and

20 a second catheter comprising a retrieval catheter having a lumen  
sized to accommodate the guidewire and the retraction members, the  
retrieval catheter being slidable over the guidewire, the lumen of the  
retrieval catheter being sized such that when the retrieval catheter is moved  
distally over the guidewire from the proximal ends towards the distal ends  
of the retraction members when the filter element is in the expanded  
deployed configuration the intermediate portions are drawn into the lumen  
25 of the retrieval catheter and the distal ends of the retraction members are  
moved towards the guidewire such that the filter element is collapsed from  
its deployed configuration to its retrieval configuration.

69. A system for filtering emboli comprising:



a first catheter comprising a delivery catheter defining a lumen extending therethrough, the delivery catheter sized to be accommodated within the lumen of the vessel;

5 a filter element having a distal end, the filter element being expandable from a collapsed delivery configuration when the filter is contained within the lumen of the delivery catheter to an expanded deployed configuration, the filter element having a shape in the expanded configuration which forms a cavity having a proximally facing opening at a proximal end of the filter element, the filter element being collapsible from  
10 the expanded deployed configuration to a retrieval configuration, the proximally facing opening being substantially closed in the retrieval configuration;

means for carrying the filter element;

15 a plurality of retraction members, each retraction member having a distal end which engages the proximal end of the filter element in the expanded configuration and a proximal end connected to the carrying means and an intermediate portion between the proximal and distal ends of the retraction member, the retraction members being configured such that when the intermediate portions of the retraction members are moved  
20 towards the carrying means the filter element is collapsed from its expanded deployed configuration to its retrieval configuration; and

25 a second catheter comprising a retrieval catheter having a lumen sized to accommodate the carrying means and the retraction members, the retrieval catheter being slidable over the carrying means, the lumen of the retrieval catheter being sized such that when the retrieval catheter is moved distally over the carrying means from the proximal ends towards the distal ends of the retraction members when the filter element is in the expanded deployed configuration the intermediate portions are drawn into the lumen of the retrieval catheter and the distal ends of the retraction members are

moved towards the carrying means such that the filter element is collapsed from its deployed configuration to its retrieval configuration.

5 70. The system of claim 69 wherein the carrying means comprises a guidewire.

71. A method for filtering emboli from blood flowing through a lumen defined by the walls of a vessel at a desired location in the vessel comprising:

10 providing a delivery catheter defining a lumen extending therethrough, the delivery catheter sized to be accommodated within the lumen of the vessel;

providing a guidewire sized to be accommodated within the lumen of the delivery catheter;

15 providing a filter element carried on a distal portion of the guidewire, the filter element having a distal end, the guidewire extending to at least the distal end of the filter element, the filter element being expandable from a collapsed delivery configuration when the filter is constrained in the lumen of the delivery catheter to an expanded deployed configuration when the filter element is unrestrained, the filter element having a shape in the  
20 expanded configuration which forms a cavity having a proximally facing opening defined by a proximally facing lip;

25 providing a plurality of retraction members, each retraction member having a distal end connected to the proximally facing lip and a proximal end connected to the guidewire and an intermediate portion between the proximal and distal ends;

providing a retrieval catheter having a lumen sized to accommodate the guidewire and the retraction members, the retrieval catheter having a distal end;

introducing the delivery catheter into the lumen of the vessel;

advancing the guidewire and filter element in its collapsed delivery configuration through the lumen of the delivery catheter until the filter element is located at the desired location;

expanding the filter element to its expanded deployed configuration;

withdrawing the delivery catheter from the vessel;

filtering emboli from blood flowing through the vessel with the filter;

advancing the retrieval catheter through the vessel distally along the guidewire while the filter element is in the expanded deployed

configuration until the distal end of the retrieval catheter is moved from the proximal ends of the retraction members towards the distal ends of the retraction members so that the intermediate portions are drawn into the lumen of the retrieval catheter and the distal ends of the retraction members are moved towards the guidewire to draw the proximally facing lip of the filter element radially inwardly in the direction of the guidewire until the proximally facing opening is substantially closed; and

withdrawing the retrieval catheter, guidewire and filter element from the vessel.

72. A method for filtering emboli from blood flowing through a lumen defined by the walls of a vessel at a desired location in the vessel comprising:

providing a delivery catheter defining a lumen extending therethrough, the delivery catheter sized to be accommodated within the lumen of the vessel;

providing a filter element having a distal end, the filter element being expandable from a collapsed delivery configuration when the filter is constrained in the lumen of the delivery catheter to an expanded deployed configuration when the filter element is unrestrained, the filter element having a shape in the expanded configuration which forms a cavity having a proximally facing opening defined by a proximally facing lip;

providing means for carrying the filter element, the carrying means extending to at least the distal end of the filter element;

providing a plurality of retraction members, each retraction member having a distal end connected to the proximally facing lip and a proximal end connected to the carrying means and an intermediate portion between the proximal and distal ends;

providing a retrieval catheter having a lumen sized to accommodate the carrying means and the retraction members, the retrieval catheter having a distal end;

introducing the delivery catheter into the lumen of the vessel;

advancing the carrying means and filter element in its collapsed delivery configuration through the lumen of the delivery catheter until the filter element is located at the desired location;

expanding the filter element to its expanded deployed configuration;

withdrawing the delivery catheter from the vessel;

filtering emboli from blood flowing through the vessel with the filter;

advancing the retrieval catheter through the vessel distally along the carrying means while the filter element is in the expanded deployed configuration until the distal end of the retrieval catheter is moved from the proximal ends of the retraction members towards the distal ends of the retraction members so that the intermediate portions are drawn into the lumen of the retrieval catheter and the distal ends of the retraction members are moved towards the carrying means to draw the proximally facing lip of the filter element radially inwardly in the direction of the carrying means until the proximally facing opening is substantially closed; and

withdrawing the retrieval catheter, carrying means and filter element from the vessel.

73. The method of claim 72 wherein in the step of providing a carrying means the carrying means comprises a guidewire.

74. A method for filtering emboli from blood flowing through the lumen of a vessel at a desired location comprising:

providing a first catheter comprising a delivery catheter defining a lumen extending therethrough, the delivery catheter sized to be accommodated within the lumen of the vessel;

providing a guidewire sized to be accommodated within the lumen of the delivery catheter;

providing a filter element carried on a distal portion of the guidewire, the filter element having a distal end, the filter element being expandable from a collapsed delivery configuration when the filter element is contained within the lumen of the delivery catheter to an expanded configuration which forms a cavity having a proximally facing opening at a proximal end of the filter element, the filter element being collapsible from the expanded deployed configuration to a retrieval configuration, the proximally facing opening being substantially closed in the retrieval configuration;

providing a plurality of retraction members, each retraction member having a distal end which engages the proximal end of the filter element in the expanded configuration and a proximal end connected to the guidewire and an intermediate portion between the proximal and distal ends, the retraction members being configured such that when the intermediate portions of the retraction members are moved towards the guidewire the filter element is collapsed from its expanded deployed configuration to its retrieval configuration;

providing a retrieval catheter different from the delivery catheter having a lumen sized to accommodate the guidewire and the retraction members, the retrieval catheter having a distal end;

introducing the delivery catheter into the lumen of the vessel;

advancing the guidewire and filter element in its collapsed delivery configuration through the lumen of the delivery catheter until the filter element is located at the desired location;

expanding the filter element to its expanded deployed configuration;

withdrawing the delivery catheter from the vessel;

filtering emboli from blood flowing through the vessel with the filter;

advancing the retrieval catheter distally through the vessel along the guidewire while the filter element is in the expanded deployed configuration until the retraction members are drawn into the lumen of the retrieval catheter causing the filter element to collapse from its expanded deployed configuration to its retrieval configuration; and

withdrawing the retrieval catheter, guidewire and filter element from the vessel.

75. A method for filtering emboli from blood flowing through the lumen of a vessel at a desired location comprising:

providing a first catheter comprising a delivery catheter defining a lumen extending therethrough, the delivery catheter sized to be accommodated within the lumen of the vessel;

providing a filter element having a distal end, the filter element being expandable from a collapsed delivery configuration when the filter element is contained within the lumen of the delivery catheter to an expanded configuration which forms a cavity having a proximally facing opening at a proximal end of the filter element, the filter element being collapsible from the expanded deployed configuration to a retrieval configuration, the proximally facing opening being substantially closed in the retrieval configuration;

providing means for carrying the filter element;

providing a plurality of retraction members, each retraction member having a distal end which engages the proximal end of the filter element in the expanded configuration and a proximal end connected to the carrying means and an intermediate portion between the proximal and distal ends, the retraction members being configured such that when the intermediate portions of the retraction members are moved towards the carrying means the filter element is collapsed from its expanded deployed configuration to its retrieval configuration;

providing a retrieval catheter different from the delivery catheter having a lumen sized to accommodate the carrying means and the retraction members, the retrieval catheter having a distal end;

introducing the delivery catheter into the lumen of the vessel;

advancing the carrying means and filter element in its collapsed delivery configuration through the lumen of the delivery catheter until the filter element is located at the desired location;

expanding the filter element to its expanded deployed configuration;

withdrawing the delivery catheter from the vessel;

filtering emboli from blood flowing through the vessel with the filter;

advancing the retrieval catheter distally through the vessel along the carrying means while the filter element is in the expanded deployed configuration until the retraction members are drawn into the lumen of the retrieval catheter causing the filter element to collapse from its expanded deployed configuration to its retrieval configuration; and

withdrawing the retrieval catheter, carrying means and filter element from the vessel.

76. The method of claim 75 wherein in the step of providing the means for carrying, the carrying means is a guidewire.

77. A system for performing an intravascular procedure at a treatment site in a lumen defined by the walls of a vessel and for filtering emboli dislodged during the procedure from blood flowing through the vessel comprising:

a delivery catheter defining a lumen extending therethrough, the delivery catheter sized to be accommodated within the lumen of the vessel;

a guidewire sized to be accommodated within the lumen of the delivery catheter;

a filter element carried on a distal portion of the guidewire, the filter element having a distal end, the filter element being expandable from a collapsed delivery configuration when the filter is contained within the lumen of the delivery catheter to an expanded deployed configuration when the filter element is unrestrained, the filter element having a shape in the expanded configuration which forms a cavity having a proximally facing opening defined by a proximally facing lip;

a plurality of retraction members, each retraction member having a distal end which engages the proximally facing lip of the filter element and a proximal end connected to the guidewire and an intermediate portion between the proximal and distal ends, the retraction members being configured such that when the intermediate portions of the retraction members are moved towards the guidewire the proximally facing lip of the filter element is drawn radially inwardly in the direction of the guidewire;

a balloon catheter having a proximal and a distal end, a proximal and a distal region, and a lumen which slidably receives the guidewire, the balloon catheter having an inflatable balloon associated with the distal region; and

a retrieval catheter having a lumen sized to accommodate the guidewire and the retraction members, the retrieval catheter being slidable over the guidewire, the lumen of the retrieval catheter being sized such that when the retrieval catheter is moved distally along the guidewire from the proximal ends of the retraction members towards the distal ends of the



retraction members when the filter element is in the expanded deployed configuration the intermediate portions are drawn into the lumen of the retrieval catheter and the distal ends of the retraction members are moved towards the guidewire.

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78. A system for performing an intravascular procedure at a treatment site in a lumen defined by the walls of a vessel and for filtering emboli dislodged during the procedure from blood flowing through the vessel comprising:

a delivery catheter defining a lumen extending therethrough, the delivery catheter sized to be accommodated within the lumen of the vessel;

a filter element having a distal end, the filter element being expandable from a collapsed delivery configuration when the filter is contained within the lumen of the delivery catheter to an expanded deployed configuration when the filter element is unrestrained, the filter element having a shape in the expanded configuration which forms a cavity having a proximally facing opening defined by a proximally facing lip;

means for carrying the filter element, the carrying means extending to at least the distal end of the filter element; and

a plurality of retraction members, each retraction member having a distal end which engages the proximally facing lip of the filter element and a proximal end connected to the carrying means and an intermediate portion between the proximal and distal ends, the retraction members being configured such that when the intermediate portions of the retraction members are moved towards the carrying means the proximally facing lip of the filter element is drawn radially inwardly in the direction of the carrying means;

a balloon catheter having a proximal and a distal end, a proximal and a distal region, and a lumen which slidably receives the carrying means, the balloon catheter having an inflatable balloon associated with the distal region; and

a retrieval catheter having a lumen sized to accommodate the carrying means and the retraction members, the retrieval catheter being slidable over the carrying means, the lumen of the retrieval catheter being sized such that when the retrieval catheter is moved distally along the carrying means from the proximal ends of the retraction members towards the distal ends of the retraction members when the filter element is in the expanded deployed configuration the intermediate portions are drawn into the lumen of the retrieval catheter and the distal ends of the retraction members are moved towards the carrying means.

79. The system of claim 78 wherein the carrying means comprises a guidewire.

80. A system for performing an intravascular procedure at a treatment site in a lumen defined by the walls of a vessel and for filtering emboli dislodged during the procedure from blood flowing through the vessel comprising:

a first catheter comprising a delivery catheter defining a lumen extending therethrough, the delivery catheter sized to be accommodated within the lumen of the vessel;

a guidewire sized to be accommodated within the lumen of the delivery catheter;

a filter element carried on a distal portion of the guidewire, the filter element having a distal end, the guidewire extending to at least the distal end of the filter element, the filter element being expandable from a collapsed delivery configuration when the filter is contained within the lumen of the delivery catheter to an expanded deployed configuration when the filter element is unrestrained, the filter element having a shape in the expanded configuration which forms a cavity having a proximally facing opening defined by a proximally facing lip;

a plurality of retraction members, each retraction member having a distal end which engages the proximally facing lip and a proximal end connected to the guidewire and an intermediate portion between the proximal and distal ends, the retraction members being configured such that when the intermediate portions of the retraction members are moved towards the guidewire the proximally facing lip of the filter element is drawn radially inwardly in the direction of the guidewire;

a balloon catheter having a proximal and a distal end, a proximal and a distal region, and a lumen which slidably receives the guidewire, the balloon catheter having an inflatable balloon associated with the distal region; and

a second catheter comprising a retrieval catheter having a lumen sized to accommodate the guidewire and the retraction members, the retrieval catheter being slidable over the guidewire, the lumen of the retrieval catheter being sized such that when the retrieval catheter is moved distally along the guidewire from the proximal ends of the retraction members towards the distal ends of the retraction members when the filter element is in the expanded deployed configuration the intermediate portions are drawn into the lumen of the retrieval catheter and the distal ends of the retraction members are moved towards the guidewire.

81. A system for performing an intravascular procedure at a treatment site in a lumen defined by the walls of a vessel and for filtering emboli dislodged during the procedure from blood flowing through the vessel comprising:

a first catheter comprising a delivery catheter defining a lumen extending therethrough, the delivery catheter sized to be accommodated within the lumen of the vessel;

a filter element having a distal end, the filter element being expandable from a collapsed delivery configuration when the filter is contained within the lumen of the delivery catheter to an expanded

deployed configuration when the filter element is unrestrained, the filter element having a shape in the expanded configuration which forms a cavity having a proximally facing opening defined by a proximally facing lip;

means for carrying the filter element, the carrying means extending to at least the distal end of the filter element; and

a plurality of retraction members, each retraction member having a distal end which engages the proximally facing lip and a proximal end connected to the carrying means and an intermediate portion between the proximal and distal ends, the retraction members being configured such that when the intermediate portions of the retraction members are moved towards the carrying means the proximally facing lip of the filter element is drawn radially inwardly in the direction of the carrying means;

a balloon catheter having a proximal and a distal end, a proximal and a distal region, and a lumen which slidably receives the carrying means, the balloon catheter having an inflatable balloon associated with the distal region; and

a second catheter comprising a retrieval catheter having a lumen sized to accommodate the carrying means and the retraction members, the retrieval catheter being slidable over the carrying means, the lumen of the retrieval catheter being sized such that when the retrieval catheter is moved distally along the carrying means from the proximal ends of the retraction members towards the distal ends of the retraction members when the filter element is in the expanded deployed configuration the intermediate portions are drawn into the lumen of the retrieval catheter and the distal ends of the retraction members are moved towards the carrying means.

82. The system of claim 81 wherein the carrying means comprises a guidewire.

83. A system for filtering emboli from blood flowing through a lumen defined by the wall of a vessel during an intravascular procedure performed at a treatment site in the vessel comprising:

a first catheter comprising a delivery catheter defining a lumen  
5 extending therethrough, the delivery catheter sized to be accommodated within the lumen of the vessel

a guidewire sized to be accommodated within the lumen of the delivery catheter;

a filter element carried on a distal portion of the guidewire, the filter  
10 element having a distal end, the filter element being expandable from a collapsed delivery configuration when the filter is contained within the lumen of the delivery catheter to an expanded deployed configuration, the filter element having a shape in the expanded configuration which forms a cavity having a proximally facing opening at a proximal end of the filter  
15 element, the filter element being collapsible from the expanded deployed configuration to a retrieval configuration, the proximally facing opening being substantially closed in the retrieval configuration;

a plurality of retraction members, each retraction member having a  
20 distal end connected to engage the proximal end of the filter element in the expanded configuration and a proximal end connected to the guidewire and an intermediate portion between the proximal and distal ends, the retraction members being configured such that when the intermediate portions of the retraction members are moved towards the guidewire the filter element is collapsed from its expanded deployed configuration to its retrieval  
25 configuration;

a balloon catheter having a proximal and a distal end, a proximal and a distal region, and a lumen which slidably receives the guidewire, the balloon catheter having an inflatable balloon associated with the distal region; and

a second catheter comprising a retrieval catheter having a lumen sized to accommodate the guidewire and the retraction members, the retrieval catheter being slidable over the guidewire, the lumen of the retrieval catheter being sized such that when the retrieval catheter is moved distally over the guidewire from the proximal ends towards the distal ends of the retraction members when the filter element is in the expanded deployed configuration the intermediate portions are drawn into the lumen of the retrieval catheter and the distal ends of the retraction members are moved towards the guidewire.

84. A system for filtering emboli from blood flowing through a lumen defined by the wall of a vessel during an intravascular procedure performed at a treatment site in the vessel comprising:

a first catheter comprising a delivery catheter defining a lumen extending therethrough, the delivery catheter sized to be accommodated within the lumen of the vessel;

a filter element having a distal end, the filter element being expandable from a collapsed delivery configuration when the filter is contained within the lumen of the delivery catheter to an expanded deployed configuration, the filter element having a shape in the expanded configuration which forms a cavity having a proximally facing opening at a proximal end of the filter element, the filter element being collapsible from the expanded deployed configuration to a retrieval configuration, the proximally facing opening being substantially closed in the retrieval configuration;

means for carrying the filter element; and

a plurality of retraction members, each retraction member having a distal end connected to engage the proximal end of the filter element in the expanded configuration and a proximal end connected to the carrying means and an intermediate portion between the proximal and distal ends,

the retraction members being configured such that when the intermediate portions of the retraction members are moved towards the carrying means the filter element is collapsed from its expanded deployed configuration to its retrieval configuration;

5           a balloon catheter having a proximal and a distal end, a proximal and a distal region, and a lumen which slidably receives the carrying means, the balloon catheter having an inflatable balloon associated with the distal region; and

10           a second catheter comprising a retrieval catheter having a lumen sized to accommodate the carrying means and the retraction members, the retrieval catheter being slidable over the carrying means, the lumen of the retrieval catheter being sized such that when the retrieval catheter is moved distally over the carrying means from the proximal ends towards the distal ends of the retraction members when the filter element is in the expanded  
15           deployed configuration the intermediate portions are drawn into the lumen of the retrieval catheter and the distal ends of the retraction members are moved towards the carrying means.

20           85.    The system of claim 84 wherein the carrying means comprises a guidewire.

86.    A system for filtering emboli from blood flowing through a lumen defined by the wall of a vessel during an intravascular procedure performed at a treatment site in the vessel comprising:

25           a first catheter comprising a delivery catheter defining a lumen extending therethrough, the delivery catheter sized to be accommodated within the lumen of the vessel

          a guidewire sized to be accommodated within the lumen of the delivery catheter;

a filter element carried on a distal portion of the guidewire, the filter element having a distal end, the guidewire extending to at least the distal end of the filter element, the filter element being expandable from a collapsed delivery configuration when the filter is contained within the lumen of the delivery catheter to an expanded deployed configuration, the filter element having a shape in the expanded configuration which forms a cavity having a proximally facing opening at a proximal end of the filter element, the filter element being collapsible from the expanded deployed configuration to a retrieval configuration, the proximally facing opening being substantially closed in the retrieval configuration;

a plurality of retraction members, each retraction member having a distal end connected to engage the proximal end of the filter element in the expanded configuration and a proximal end connected to the guidewire and an intermediate portion between the proximal and intermediate portions, the retraction members being configured such that when the distal ends of the retraction members are moved towards the guidewire the filter element is collapsed from its expanded deployed configuration to its retrieval configuration;

a balloon catheter having a proximal and a distal end, a proximal and a distal region, and a lumen which slidably receives the guidewire, the balloon catheter having an inflatable balloon associated with the distal region; and

a second catheter comprising a retrieval catheter different from the delivery catheter having a lumen sized to accommodate the guidewire and the retraction members, the retrieval catheter being slidable over the guidewire, the lumen of the retrieval catheter being sized such that when the retrieval catheter is moved distally over the guidewire from the proximal ends towards the distal ends of the retraction members when the filter element is in the expanded deployed configuration the intermediate portions



are drawn into the lumen of the retrieval catheter and the distal ends of the retraction members are moved towards the guidewire.

87. A system for filtering emboli from blood flowing through a lumen defined by the wall of a vessel during an intravascular procedure performed at a treatment site in the vessel comprising:

a first catheter comprising a delivery catheter defining a lumen extending therethrough, the delivery catheter sized to be accommodated within the lumen of the vessel

a filter element, the filter element being expandable from a collapsed delivery configuration when the filter is contained within the lumen of the delivery catheter to an expanded deployed configuration, the filter element having a shape in the expanded configuration which forms a cavity having a proximally facing opening at a proximal end of the filter element, the filter element being collapsible from the expanded deployed configuration to a retrieval configuration, the proximally facing opening being substantially closed in the retrieval configuration;

means for carrying the filter element, the carrying means extending to at least the distal end of the filter element;

a plurality of retraction members, each retraction member having a distal end connected to engage the proximal end of the filter element in the expanded configuration and a proximal end connected to the carrying means and an intermediate portion between the proximal and intermediate portions, the retraction members being configured such that when the distal ends of the retraction members are moved towards the carrying means the filter element is collapsed from its expanded deployed configuration to its retrieval configuration;

a balloon catheter having a proximal and a distal end, a proximal and a distal region, and a lumen which slidably receives the carrying means, the

balloon catheter having an inflatable balloon associated with the distal region; and

a second catheter comprising a retrieval catheter different from the delivery catheter having a lumen sized to accommodate the carrying means and the retraction members, the retrieval catheter being slidable over the carrying means, the lumen of the retrieval catheter being sized such that when the retrieval catheter is moved distally over the carrying means from the proximal ends towards the distal ends of the retraction members when the filter element is in the expanded deployed configuration the intermediate portions are drawn into the lumen of the retrieval catheter and the distal ends of the retraction members are moved towards the carrying means.

88. The system of claim 87 wherein the carrying means comprises a guidewire.

89. A method for performing an intravascular procedure at a treatment site in a lumen defined by the walls of a vessel and for filtering emboli dislodged during the procedure from blood flowing through the vessel comprising:

providing a delivery catheter defining a lumen extending therethrough, the delivery catheter sized to be accommodated within the lumen of the vessel;

providing a guidewire sized to be accommodated within the lumen of the delivery catheter;

providing a filter element carried on a distal portion of the guidewire, the filter element having a distal end, the filter element being expandable from a collapsed delivery configuration when the filter is constrained in the lumen of the delivery catheter to an expanded deployed configuration when the filter element is unrestrained, the filter element having a shape in the



retraction members so that the intermediate portions are drawn into the lumen of the retrieval catheter and the distal ends of the retraction members are moved towards the guidewire to draw the proximally facing lip of the filter element radially inwardly in the direction of the guidewire until the proximally facing opening is substantially closed; and

withdrawing the retrieval catheter, guidewire and filter element from the vessel.

90. The method of claim 89 wherein the filter is expanded before the balloon catheter is advanced over the guidewire.

91. The method of claim 89 wherein the filter is expanded after the balloon catheter is advanced over the guidewire.

92. The method of claim 89 wherein the filter is expanded before the balloon is inflated.

93. The method of claim 91 wherein the filter is expanded before the balloon is inflated.

94. A method for performing an intravascular procedure at a treatment site in a lumen defined by the walls of a vessel and for filtering emboli dislodged during the procedure from blood flowing through the vessel comprising:

providing a delivery catheter defining a lumen extending therethrough, the delivery catheter sized to be accommodated within the lumen of the vessel;

providing a filter element having a distal end, the filter element being expandable from a collapsed delivery configuration when the filter is constrained in the lumen of the delivery catheter to an expanded deployed configuration when the filter element is unrestrained, the filter element

having a shape in the expanded configuration which forms a cavity having a proximally facing opening defined by a proximally facing lip;

providing means for carrying the filter element;

5 providing a plurality of retraction members, each retraction member having a distal end connected to engage the proximally facing lip and a proximal end connected to the carrying means and an intermediate portion between the proximal and distal ends;

10 providing a balloon catheter having a proximal and a distal end, a proximal and a distal region, and a lumen which slidably receives the carrying means, the balloon catheter having an inflatable balloon associated with the distal region;

providing a retrieval catheter having a lumen sized to accommodate the carrying means and the retraction members, the retrieval catheter having a distal end;

15 introducing the delivery catheter into the lumen of the vessel;

advancing the carrying means and filter element in its collapsed delivery configuration through the lumen of the delivery catheter until the filter element is located at the desired location;

20 expanding the filter element to its expanded deployed configuration;

withdrawing the delivery catheter from the vessel;

advancing the balloon catheter through the vessel over the carrying means until the balloon is positioned at the treatment site;

inflating the balloon during performance of the intravascular procedure;

25 filtering emboli from blood flowing through the vessel with the filter;

removing the balloon catheter from the vessel;

30 advancing the retrieval catheter through the vessel distally along the carrying means while the filter element is in the expanded deployed configuration until the distal end of the retrieval catheter is moved from the

proximal ends of the retraction members towards the distal ends of the retraction members so that the intermediate portions are drawn into the lumen of the retrieval catheter and the distal ends of the retraction members are moved towards the carrying means to draw the proximally facing lip of the filter element radially inwardly in the direction of the carrying means until the proximally facing opening is substantially closed; and withdrawing the retrieval catheter, carrying means and filter element from the vessel.

95. The method of claim 94 wherein in the step of providing the carrying means the carrying means is a guidewire.

96. A method for performing an intravascular procedure at a treatment site in a lumen defined by the walls of a vessel and for filtering emboli dislodged during the procedure from blood flowing through the vessel comprising:

providing a first catheter comprising a delivery catheter defining a lumen extending therethrough, the delivery catheter sized to be accommodated within the lumen of the vessel;

providing a guidewire sized to be accommodated within the lumen of the delivery catheter;

providing a filter element carried on a distal portion of the guidewire, the filter element having a distal end, the guidewire extending to at least the distal end of the filter element, the filter element being expandable from a collapsed delivery configuration when the filter is constrained in the lumen of the delivery catheter to an expanded deployed configuration when the filter element is unrestrained, the filter element having a shape in the expanded configuration which forms a cavity having a proximally facing opening defined by a proximally facing lip;

providing a plurality of retraction members, each retraction member having a distal end connected to engage the proximally facing lip and a

proximal end connected to the guidewire and an intermediate portion between the proximal and distal ends;

5 providing a balloon catheter having a proximal and a distal end, a proximal and a distal region, and a lumen which slidably receives the guidewire, the balloon catheter having an inflatable balloon associated with the distal region;

providing a second catheter comprising a retrieval catheter having a lumen sized to accommodate the guidewire and the retraction members, the retrieval catheter having a distal end;

10 introducing the delivery catheter into the lumen of the vessel;

advancing the guidewire and filter element in its collapsed delivery configuration through the lumen of the delivery catheter until the filter element is located at the desired location;

expanding the filter element to its expanded deployed configuration;

15 withdrawing the delivery catheter from the vessel;

advancing the balloon catheter through the vessel over the guidewire until the balloon is positioned at the treatment site;

inflating the balloon during performance of the intravascular procedure;

20 filtering emboli from blood flowing through the vessel with the filter;

removing the balloon catheter from the vessel;

25 advancing the retrieval catheter through the vessel distally along the guidewire while the filter element is in the expanded deployed configuration until the distal end of the retrieval catheter is moved from the proximal ends of the retraction members towards the distal ends of the retraction members so that the intermediate portions are drawn into the lumen of the retrieval catheter and the distal ends of the retraction members are moved towards the guidewire to draw the proximally facing lip of the

filter element radially inwardly in the direction of the guidewire until the proximally facing opening is substantially closed; and

withdrawing the retrieval catheter, guidewire and filter element from the vessel.

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97. The method of claim 96 wherein the filter is expanded before the balloon catheter is advanced over the guidewire.

98. The method of claim 96 wherein the filter is expanded after the  
10 balloon catheter is advanced over the guidewire.

99. The method of claim 98 wherein the filter is expanded before the balloon is inflated.

15 100. A method for performing an intravascular procedure at a treatment site in a lumen defined by the walls of a vessel and for filtering emboli dislodged during the procedure from blood flowing through the vessel comprising:

providing a first catheter comprising a delivery catheter defining a lumen extending therethrough, the delivery catheter sized to be  
20 accommodated within the lumen of the vessel;

providing a filter element having a distal end, the filter element being expandable from a collapsed delivery configuration when the filter is constrained in the lumen of the delivery catheter to an expanded deployed configuration when the filter element is unrestrained, the filter element  
25 having a shape in the expanded configuration which forms a cavity having a proximally facing opening defined by a proximally facing lip;

providing means for carrying the filter element, the carrying means extending to at least the distal end of the filter element; and

30 providing a plurality of retraction members, each retraction member having a distal end connected to engage the proximally facing lip and a



proximal end connected to the carrying means and an intermediate portion between the proximal and distal ends;

5 providing a balloon catheter having a proximal and a distal end, a proximal and a distal region, and a lumen which slidably receives the carrying means, the balloon catheter having an inflatable balloon associated with the distal region;

providing a second catheter comprising a retrieval catheter having a lumen sized to accommodate the carrying means and the retraction members, the retrieval catheter having a distal end;

10 introducing the delivery catheter into the lumen of the vessel;

advancing the carrying means and filter element in its collapsed delivery configuration through the lumen of the delivery catheter until the filter element is located at the desired location;

15 expanding the filter element to its expanded deployed configuration;

withdrawing the delivery catheter from the vessel;

advancing the balloon catheter through the vessel over the carrying means until the balloon is positioned at the treatment site;

inflating the balloon during performance of the intravascular procedure;

20 filtering emboli from blood flowing through the vessel with the filter;

removing the balloon catheter from the vessel;

25 advancing the retrieval catheter through the vessel distally along the carrying means while the filter element is in the expanded deployed configuration until the distal end of the retrieval catheter is moved from the proximal ends of the retraction members towards the distal ends of the retraction members so that the intermediate portions are drawn into the lumen of the retrieval catheter and the distal ends of the retraction members are moved towards the carrying means to draw the proximally facing lip of

the filter element radially inwardly in the direction of the carrying means until the proximally facing opening is substantially closed; and  
withdrawing the retrieval catheter, carrying means and filter element from the vessel.

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101. The method of claim 100 wherein in the step of providing carrying means the carrying means comprises a guidewire.

102. The method of claim 100 wherein the filter is expanded before the  
10 balloon catheter is advanced over the carrying means.

103. The method of claim 100 wherein the filter is expanded after the balloon catheter is advanced over the carrying means.

104. The method of claim 100 wherein the filter is expanded before the  
15 balloon is inflated.

105. The method of claim 103 wherein the filter is expanded before the  
balloon is inflated.

20

106. A method for performing an intravascular procedure at a treatment site in a lumen defined by the walls of a vessel and for filtering emboli dislodged during the procedure from blood flowing through the vessel comprising:

25 providing a delivery catheter defining a lumen extending therethrough, the delivery catheter sized to be accommodated within the lumen of the vessel;

providing a guidewire sized to be accommodated within the lumen of the delivery catheter;

30 providing a filter element carried on a distal portion of the guidewire, the filter element having a distal end, the filter element being expandable

from a collapsed delivery configuration when the filter element is contained within the lumen of the delivery catheter to an expanded configuration which forms a cavity having a proximally facing opening at a proximal end of the filter element, the filter element being collapsible from the expanded deployed configuration to a retrieval configuration, the proximally facing opening being substantially closed in the retrieval configuration;

providing a plurality of retraction members, each retraction member having a distal end connected to engage the proximal end of the filter element in the expanded configuration and a proximal end connected to the guidewire and an intermediate portion between the proximal and distal ends, the retraction members being configured such that when the intermediate portions of the retraction members are moved towards the guidewire the filter element is collapsed from its expanded deployed configuration to its retrieval configuration;

providing a balloon catheter having a proximal and a distal end, a proximal and a distal region, and a lumen which slidably receives the guidewire, the balloon catheter having an inflatable balloon associated with the distal region;

providing a retrieval catheter having a lumen sized to accommodate the guidewire and the retraction members, the retrieval catheter having a distal end;

introducing the delivery catheter into the lumen of the vessel;

advancing the guidewire and filter element in its collapsed delivery configuration through the lumen of the delivery catheter until the filter element is located at the desired location;

expanding the filter element to its expanded deployed configuration;

withdrawing the delivery catheter from the vessel;

advancing the balloon catheter through the vessel over the guidewire until the balloon is positioned at the treatment site;

inflating the balloon during performance of the intravascular procedure

filtering emboli from blood flowing through the vessel with the filter;

5 removing the balloon catheter from the vessel;

advancing the retrieval catheter distally through the vessel along the guidewire while the filter element is in the expanded deployed configuration until the retraction members are drawn into the lumen of the retrieval catheter causing the filter element to collapse from its expanded deployed configuration to its retrieval configuration; and

10 withdrawing the retrieval catheter, guidewire and filter element from the vessel.

107. The method of claim 106 wherein the filter is expanded before the balloon catheter is advanced over the guidewire.

108. The method of claim 106 wherein the filter is expanded after the balloon catheter is advanced over the guidewire.

20 109. The method of claim 108 wherein the filter is expanded before the balloon is inflated.

110. A method for performing an intravascular procedure at a treatment site in a lumen defined by the walls of a vessel and for filtering emboli dislodged during the procedure from blood flowing through the vessel comprising:

providing a delivery catheter defining a lumen extending therethrough, the delivery catheter sized to be accommodated with the lumen of the vessel;

30 providing a filter element having a distal end, the filter element being expandable from a collapsed delivery configuration when the filter element

is contained within the lumen of the delivery catheter to an expanded configuration which forms a cavity having a proximally facing opening at a proximal end of the filter element, the filter element being collapsible from the expanded deployed configuration to a retrieval configuration, the proximally facing opening being substantially closed in the retrieval configuration;

providing means for carrying the filter element;

providing a plurality of retraction members, each retraction member having a distal end connected to engage the proximal end of the filter element in the expanded configuration and a proximal end connected to the carrying means and an intermediate portion between the proximal and distal ends, the retraction members being configured such that when the intermediate portions of the retraction members are moved towards the carrying means the filter element is collapsed from its expanded deployed configuration to its retrieval configuration;

providing a balloon catheter having a proximal and a distal end, a proximal and a distal region, and a lumen which slidably receives the carrying means, the balloon catheter having an inflatable balloon associated with the distal region;

providing a retrieval catheter having a lumen sized to accommodate the carrying means and the retraction members, the retrieval catheter having a distal end;

introducing the delivery catheter into the lumen of the vessel;

advancing the carrying means and filter element in its collapsed delivery configuration through the lumen of the delivery catheter until the filter element is located at the desired location;

expanding the filter element to its expanded deployed configuration;

withdrawing the delivery catheter from the vessel;

advancing the balloon catheter through the vessel over the carrying means until the balloon is positioned at the treatment site;

inflating the balloon during performance of the intravascular procedure

filtering emboli from blood flowing through the vessel with the filter;

5 removing the balloon catheter from the vessel;

advancing the retrieval catheter distally through the vessel along the carrying means while the filter element is in the expanded deployed configuration until the retraction members are drawn into the lumen of the retrieval catheter causing the filter element to collapse from its expanded deployed configuration to its retrieval configuration; and

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withdrawing the retrieval catheter, carrying means and filter element from the vessel.

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111. The method of claim 110 wherein in the step of providing a carrying means the carrying means comprises a guidewire.

112. The method of claim 110 wherein the filter is expanded before the balloon catheter is advanced over the carrying means.

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113. The method of claim 110 wherein the filter is expanded after the balloon catheter is advanced over the carrying means.

114. The method of claim 110 wherein the filter is expanded before the balloon is inflated.

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115. The method of claim 113 wherein the filter is expanded before the balloon is inflated.

116. A method for performing an intravascular procedure at a treatment site in a lumen defined by the walls of a vessel and for filtering emboli dislodged during the procedure from blood flowing through the vessel comprising:

- 5 providing a first catheter comprising a delivery catheter defining a lumen extending therethrough, the delivery catheter sized to be accommodated within the lumen of the vessel;
- providing a guidewire sized to be accommodated within the lumen of the delivery catheter;
- 10 providing a filter element carried on a distal portion of the guidewire, the filter element having a distal end, the guidewire extending to at least the distal end of the filter element, the filter element being expandable from a collapsed delivery configuration when the filter element is contained within the lumen of the delivery catheter to an expanded configuration which forms a cavity having a proximally facing opening at a proximal end of the filter element, the filter element being collapsible from the expanded deployed configuration to a retrieval configuration, the proximally facing opening being substantially closed in the retrieval configuration;
- 15 providing a plurality of retraction members, each retraction member having a distal end connected to engage the proximal end of the filter element in the expanded configuration and a proximal end connected to the guidewire and an intermediate portion between the proximal and distal ends, the retraction members being configured such that when the intermediate portions of the retraction members are moved towards the guidewire the filter element is collapsed from its expanded deployed configuration to its retrieval configuration;
- 20 providing a balloon catheter having a proximal and a distal end, a proximal and a distal region, and a lumen which slidably receives the guidewire, the balloon catheter having an inflatable balloon associated with the distal region;
- 25

providing a second catheter comprising a retrieval catheter having a lumen sized to accommodate the guidewire and the retraction members, the retrieval catheter having a distal end;

introducing the delivery catheter into the lumen of the vessel;

5        advancing the guidewire and filter element in its collapsed delivery configuration through the lumen of the delivery catheter until the filter element is located at the desired location;

expanding the filter element to its expanded deployed configuration;

withdrawing the delivery catheter from the vessel;

10       advancing the balloon catheter through the vessel over the guidewire until the balloon is positioned at the treatment site;

inflating the balloon during performance of the intravascular procedure

15       filtering emboli from blood flowing through the vessel with the filter;

removing the balloon catheter from the vessel;

20       advancing the retrieval catheter distally through the vessel along the guidewire while the filter element is in the expanded deployed configuration until the retraction members are drawn into the lumen of the retrieval catheter causing the filter element to collapse from its expanded deployed configuration to its retrieval configuration; and

withdrawing the retrieval catheter, guidewire and filter element from the vessel.

25       117. The method of claim 116 wherein the filter is expanded before the balloon catheter is advanced over the guidewire.

118. The method of claim 116 wherein the filter is expanded after the balloon catheter is advanced over the guidewire.

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119. The method of claim 116 wherein the filter is expanded before the balloon is inflated.

120. The method of claim 118 wherein the filter is expanded before the  
5 balloon is inflated.

121. A method for performing an intravascular procedure at a treatment site in a lumen defined by the walls of a vessel and for filtering emboli dislodged during the procedure from blood flowing through the vessel comprising:

10 providing a first catheter comprising a delivery catheter defining a lumen extending therethrough, the delivery catheter sized to be accommodated within the lumen of the vessel;

providing a filter element having a distal end, the filter element being expandable from a collapsed delivery configuration when the filter element is contained within the lumen of the delivery catheter to an expanded  
15 configuration which forms a cavity having a proximally facing opening at a proximal end of the filter element, the filter element being collapsible from the expanded deployed configuration to a retrieval configuration, the proximally facing opening being substantially closed in the retrieval  
20 configuration;

providing means for carrying the filter element, the carrying means extending to at least the distal end of the filter element; and

providing a plurality of retraction members, each retraction member having a distal end connected to engage the proximal end of the filter  
25 element in the expanded configuration and a proximal end connected to the carrying means and an intermediate portion between the proximal and distal ends, the retraction members being configured such that when the intermediate portions of the retraction members are moved towards the carrying means the filter element is collapsed from its expanded deployed  
30 configuration to its retrieval configuration;

providing a balloon catheter having a proximal and a distal end, a proximal and a distal region, and a lumen which slidably receives the carrying means, the balloon catheter having an inflatable balloon associated with the distal region;

5 providing a second catheter comprising a retrieval catheter having a lumen sized to accommodate the carrying means and the retraction members, the retrieval catheter having a distal end;

introducing the delivery catheter into the lumen of the vessel;

10 advancing the carrying means and filter element in its collapsed delivery configuration through the lumen of the delivery catheter until the filter element is located at the desired location;

expanding the filter element to its expanded deployed configuration;

withdrawing the delivery catheter from the vessel;

15 advancing the balloon catheter through the vessel over the carrying means until the balloon is positioned at the treatment site;

inflating the balloon during performance of the intravascular procedure

filtering emboli from blood flowing through the vessel with the filter;

20 removing the balloon catheter from the vessel;

advancing the retrieval catheter distally through the vessel along the carrying means while the filter element is in the expanded deployed configuration until the retraction members are drawn into the lumen of the retrieval catheter causing the filter element to collapse from its expanded deployed configuration to its retrieval configuration; and

25 withdrawing the retrieval catheter, carrying means and filter element from the vessel.

122. The method of claim 121 wherein in the step of providing a carrying  
30 means the carrying means comprises a guidewire.

123. The method of claim 121 wherein the filter is expanded before the balloon catheter is advanced over the carrying means.

5 124. The method of claim 121 wherein the filter is expanded after the balloon catheter is advanced over the carrying means.

125. The method of claim 121 wherein the filter is expanded before the balloon is inflated.

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126. The method of claim 124 wherein the filter is expanded before the balloon is inflated.